

MEMOIRS
OF THE
GEOLOGICAL SURVEY
OF
THE UNITED KINGDOM.

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*Figures and Descriptions*

ILLUSTRATIVE OF  
BRITISH ORGANIC REMAINS.

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DECADE V.  
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BRITISH FOSSILS.

DECADE THE FIFTH.

IN apologizing for the unavoidable delay which has taken place in the publication of this Decade, owing to the much lamented decease of Professor Edward Forbes, it is right to state that the materials left behind by him were scanty, and had been unfortunately mislaid a short time before his death. The first description only, that of *Solaster Moretonis*, had been fully written by him; of the others, we had here and there notes on the distinctive characters of the species, and of his views as to their synonymy or history. The plates, however, had been all engraved under his own eye, and the specific designations under which he wished the figures to stand, were recorded in the last edition of Morris's Catalogue. He had there also applied MS. names to a number of species to be described in the Decade.

In a few cases only it has been found necessary to alter some of these names; and this has been done in deference to an authority which would have been gladly admitted by Professor Forbes. To Mr. S. P. Woodward, of the British Museum, we are indebted for all the notes respecting these supplementary species; and he has also furnished full descriptions of three of the plates. With this valuable aid, and the friendly communications of Dr. T. Wright, of Cheltenham, we can present the Decade in nearly as complete a form as it would have possessed had our friend and Master lived to finish it. We miss, however, his lively remembrance of the living species, and his practical acquaintance with their variations,—deficiencies not to be supplied by reference to his published works.

Of the ten species figured three are new,—*Solaster Moretonis*, *Cidaris Carteri*, and *Pygaster conoideus*. Of the other genera, *Diadema*, *Echinopsis*, and *Echinus* present us with well-known types from the Oolitic rocks, which are continental as well as British. *Pyrina* is a rare genus in England, and in this, and the two figured species of *Pygaster*, we have excellent examples of that division of the *Cassidulidae* in which the ambulacra are of uniform character throughout. Several genera of this type have been figured in the Decades. The *Pygaster semisulcatus* is a critical species, and its synonymy is now for the first time cleared up. *Hemiaster Murchisonia* is another instance of the same kind, and belongs to a large genus of closely allied species. The *Brissus Scilla* is a Crag species still existing in the Mediterranean. None of these nine genera have before appeared in the Decades.

There are engraved plates sufficient for another fasciculus, upon which Professor Forbes left no memoranda, except the names of the species. These Plates will be published at a future period.

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Palaeontologist.

Geological Survey Office, Jermyn Street, London,
February 1856.

BRITISH FOSSILS.

DECADE V. PLATE IV.

ECHINUS PERLATUS.

[Genus ECHINUS, LINN. (Sub-kingdom Radiata. Class Echinodermata. Order Echinidæ. Family Cidaridæ.) Body inflated; interambulacral area composed of numerous plates; ambulacral area about half the width of the others, and with tubercles of as large a size; pores in transverse, oblique, or arched ranks of three or four pairs; anus covered by numerous small plates, and surrounded by five genital plates, one of which (the left posterior, Müller) is considerably enlarged, and bears the madreporiform tubercle.]

DIAGNOSIS. *E. biuncialis*, *rotundus seu pentagonus*, *supra granulosus*, *subtus muricato-tuberculatus*; *ore pentagono angulis bifidis*. *Tubercula primaria conspicua*, *in utraq[ue] areâ bina*, *in singula serie ambulacri circa 38*,—*interambulacri 29*—*secundariis supra minoribus paucis sæpe nullis*, *subtus maximis numerosis*; *granulis crebris conspicuis*. *Ambulacra vix latitudine dimidium interambulacrorum attingentia sæpe prominula*. *Pori in series triplices parallelas*—*in juniore plus minusve obliquas*, *collocati*.

SYNONYMS. KNORR, Rec. des Mon. (1768), pl. E. 2. fig. 1, 2. LESKE apud KLEIN (1778), p. 92. pl. 40. fig. 7. (*nisi icones illæ E. gyrato potius referendæ*). *Echinus perlatus*, DESMAREST (1825), Dict. Sc. Nat., t. 37. p. 100. FORBES (1854), in Morris's Catalogue, 2nd edit. WRIGHT (1851), Ann. and Mag. N. Hist., vol. viii. 2nd ser. 274.

VAR. α , *germinans*, fig. 1–4.—*Pentagonus conicus*, *in medio interambulacri depressus*, *sæpe lævigatus*; *basi subplano*; *angulis oris productis*; *tuberculis secundariis insuper paucis*; *poris parallelis*.—*E. germinans*, PHILLIPS (1835), Geol. Yorkshire, pl. 3. fig. 15. *E. diademata*, M'Coy (1848), Ann. Nat. Hist., vol. ii. p. 410.

VAR. β , *perlatus*.—*Rotundus inflatus elevatus seu subdepressus*, *basi subconvexo*; *tuberculis secundariis numerosis magnis*, *granulis valde conspicuis*; *poris in series parallelas plerumque collatis*.—*E. perlatus*, AGASS., Ech. Suisses (1839), t. 22. fig. 13–15. *E. psammophorus*, *ibid.*, fig. 1–3. *E. lineatus*, GOLDFUSS (1826), Petr. Germ., t. 40. fig. 11. *E. perlatus*,

AGASSIZ and DESOR (1846), Cat. Raisonné, Ann. Sc. Nat. 3rd series, vol. vi. p. 365. *E. multigranularis*, COTTEAU (1850), Etudes Ech. Foss. de l'Yonne, p. 63. tab. 7. fig. 6-8.

VAR. γ , *serialis*, fig. 5.—*Depressus granulosus, tuberculis primariis ambulacralibus minoribus, secundariis insuper rarissimis, ad latera interambulacrorum in serie unica dispositis; fasciis pororum latis; poris parallelis: basi subconvexa; ore angulis obtusiusculis.*—*E. serialis*, AGASSIZ, Ech. Foss. Suisses, l. c. fig. 10-12. WRIGHT, Ann. and Mag. Nat. Hist., l. c. pl. 13. fig. 2. AG. and DESOR, l. c. p. 366.

VAR. δ , *Forbesii*, fig. 6.—*Rotundus seu pentagonus granulosus; tuberculis primariis conspicuis, ambulacralibus minoribus irregularibus: fasciis pororum angustis, seriebus usque ad orem valde obliquis.*

At first sight it would appear very unlikely that the forms here figured should be all of one species, or that either of them could be identified with the much rougher and more globose *Echinus*, which Agassiz calls "sans contredit l'un des plus beaux oursins connus."

The comparison of the several English specimens, however, with one another, and with the foreign types, convinced both Prof. Forbes and Dr. Wright that they were identical, and as such they have been quoted in the second edition of Morris's Catalogue.

Agassiz has placed this fossil species and several others allied to it with his first section of the genus, in which the pores are arranged in triple oblique (not arched) rows, and in which the buccal membrane, instead of being covered all over with calcareous plates, has only five escutcheon-like plates disposed around the mouth. The margin of the latter is deeply notched, and in these notches lie those curious branched processes which Prof. Forbes counted analogous to the oral tentacula of the *Holothuræ* (Prof. Müller terms them 'tree-like gills').

Description.—The variety *germinans*, forming the principal subject of our plate, requires more particular notice. It is conical and elevated above, flattened and even excavated below. Diameter of the largest English specimen, 3 inches, its height 2 inches. The outline, looking from above, is subpentagonal rather than rounded; the ambulacral areæ being rather more convex than the others, which are depressed along their median line.

The breadth of the interambulacral spaces is $2\frac{1}{2}$ times that of the ambulacra at the widest part; the number of plates in a row is twenty-nine, of which eight are basal, and, in English specimens, bear three or four very large primary tubercles, with a few secondaries at the outer angles. At the turn of the margin these all disappear, and the upper plates only bear each a single primary,

of a smaller size, in the middle, flanked by a row of secondary tubercles on the inner side, and one or two rows on the outer margin towards the avenues. These secondary tubercles, except the outer rows, do not, in our largest specimens, reach above half way up the test, and these rows, on the base, are nearly equal to the primaries in size.

The two principal rows of primary tubercles lie nearer to the ambulacral rows than to each other; they are the only ones which extend all the way from the apex to the base. Their tubercles are rather closely placed, and nearly of equal size throughout, while those of the ambulacral rows are smaller towards the apex. They are placed upon rather sunk mammillæ, which are smooth-edged above, but often present indications of the radiated muscular markings on their outer margin. Each has surrounding it a circle of granules of considerable size, and the entire surface of the plates is covered pretty equally with similar granules, except above along the median line of the interambulacra, where, for a short space, the surface is bare.*

The ambulacra are pointed above, but parallel sided below; the tubercles in two rows, about thirty-eight in a row, of which ten are basal ones; and between these, on the lower surface only, and in large specimens, are four or five others of equal size, in a zig-zag row. Granules surround the tubercles, and fill up the surface as in the interambulacral spaces; but here and there along the sutural line the surface is smooth. The poriferous avenues are slightly sunk beneath the general surface, especially near the mouth. Their breadth above is about half that of the rest of the ambulacral space, —a little less at the turn of the margin, and then again it widens out considerably. The pores are ranked in threes, in parallel and but slightly oblique rows in this variety (with a row of about three granules between each set), except near the apex, where the ranks are much more oblique. Each pair of pores is surrounded by an oval ring, and set obliquely, but not so much so as in our figure. There is no tubercle or bar between the pores. The mouth is pentagonal, with two deeply incised notches at each angle beneath the interambulacral spaces. Between these the oral margin is rounded, but beneath the ambulacra it is nearly a straight line. The apical disk is well preserved; we have figured it from both varieties; the round variety (fig. 6), in which the ovarian plates are somewhat more obtuse, and the var. *germinans*. In the latter the five genital

* This character exists to a much greater extent in the closely allied *E. gyratus*, Ag.

plates are heptagonal, with a broad indented base, and pierced near their outer margin by the ovarian pore; the five oculars between them are small pentagons pierced also near their base or outer edge. A circle drawn round the plates of the disk would touch or nearly touch the outer edges of all, excepting the madreporiform plate, which is generally swelled as well as enlarged, at least in the pentagonal variety.

Variations.—If all the specimens on our plate be referable to the same species, the species is a very variable one indeed. It varies in height,—from a rotund to a pentagonal and even sub-lobed form,—and very greatly in the degree of development of its tubercles and of the granules of the test. These last are, in the typical foreign examples, of considerable prominence, so much so as partly to obscure the primary rows; while in our British examples, though we have a few that show as many secondary tubercles, yet these last are always smaller, and in the extreme variety (*Forbesii*, fig. 6, if variety it be), the surface is pretty uniformly covered with small granules, amongst which the rows of large tubercles are conspicuous, both on the interambulacral and ambulacral areas. This kind of arrangement gives its character also to the next variety, called *E. serialis* by Agassiz; the large tubercles are not in reality more prominent than in other varieties, but they appear so from the want of secondary tubercles among them.

VAR. Forbesii, fig. 6.—Besides the circular inflated form, in which it resembles *E. perlatus*, and differs from the variety above described, a view of the underside of this variety shows a distinction in the mouth, which Prof. Forbes has noted in his MSS.: “The mouth notches are acute,” he says, “in *E. perlatus* (the pentagonal form), obtuse in *E. serialis** (our figured specimen, fig. 6). Moreover, in *E. perlatus* the pairs of pores are much less oblique, so that the series become parallel on the upper surface of the test as well as below; whereas in *serialis* the pores are only subparallel, beginning from the fourth row of pores from the mouth.” This is a character which occurs in the young of other varieties, but *only* near the apex. Probably older specimens of the *var. Forbesii* would have the pores more parallel. The avenues are very little sunk either on the upper or lower face of the test, and the interambulacral spaces not at all indented along their middle. The arrangement of the tubercles is much the same, as in *var. germinans*, but in the outer

* Prof E. Forbes regarded this variety as the *E. serialis* of Agassiz; but for the reasons assigned in the next page it is here described as *var. Forbesii*.

interambulacral rows appear not to extend so far up, and in the ambulacra there are fewer large tubercles developed.

VAR. *serialis*.—We prefer to apply this name, as Dr. Wright has done, to the depressed variety with pores in close ranks of threes, rather than to our figure 6, which has them oblique. Agassiz's small figure shows close set tubercles in the ambulacral areas, and those two rows are made greatly nearer to each other than to the interambulacral rows, while the pores are described as "no less in ranks of threes than those of *E. perlatus*." These two characters, the approximate ambulacral rows, and the close ranked pores, agree with specimens from Verona in the British Museum, and with the larger specimen described by Dr. Wright, as above quoted. This specimen is very evenly covered with granules, and the ambulacral tubercles, more numerous than in the typical variety or in var. *germinans*, are remarkably irregular in size (see our fig. 5). Some specimens of this variety in the Survey collections are considerably more pentagonal than our figure, and have the ambulacral rows wider apart, but have the surface and the pores similar.

VAR. *perlatus*.—In the typical variety the form is much inflated, and also moderately elevated. The avenues are broad and not sunk, though the ambulacra project a little. The tubercles are prominent in both areas, and surrounded by conspicuous large granules, intermixed with secondary tubercles on both sides of the primaries over a great part of the surface. These become equal in size to the primaries on the under surface, which is therefore crowded with large tubercles. The median line of the interambulacra is bare of granules (but not depressed), and they are occasionally absent down the middle of the convex ambulacra. In one fine specimen in the British Museum, like that figured by Goldfuss as *E. lineatus*, the rows of pores are in close threes all the way up; in another, more elevated, this arrangement alters at the upper third, and the rows become quite as oblique as in our figures 5, 6. The base of *E. perlatus* is convex, more so in depressed specimens, and the angles of the mouth are produced. Not yet found in Britain.

There is a considerable interval between this variety and the next, but there can be little doubt of their identity as species.

VAR. *germinans*.—The differences observable among specimens of this variety are chiefly those due to age (the young being more depressed), and having the pores *more oblique*; some of those from the Inferior Oolite, however, are less pentagonal, and with the median line of the interambulacra less depressed, and not so bare

of tubercles at the upper part as those from Yorkshire, while the granules are also less conspicuous. Some specimens have the ambulacra more prominent than others, and the avenues a little sunk. The mouth varies in shape and in the depth of the notches. The anus is rounder when young, and more angular in old specimens.

History.—Knorr's old figures of this fossil are tolerably characteristic, and it is generally believed he intended this species. He refers also to Klein; and in Leske's "Additamenta" to that author (1778), Knorr's figure is wretchedly copied, and made to look like a many-lobed species.* The specimens were found with acicular spines in connexion with them at Pfeffingen, in Basle, from which locality Desmoulins quotes the species as one he had not seen.

Agassiz and Desor, in the Catalogue Raisonné, refer to Desmarest for the name. His short description, in the Dict. des Sc. Nat., states that his specimen had no locality, but that it was probably from beds older than the chalk, and that others very like it were found in the Jura. Goldfuss, in 1826, gave an excellent figure of it, under the name of *E. lineatus*, showing clearly the granules in circles round the tubercles, and also the parallel rows of pores. He has well expressed the general rough appearance of the species, even better than in Agassiz's more complete figure in the Ech. Suisses. In that work a smaller variety was figured, and called by Agassiz *E. psammophorus*, which he afterwards united with the larger species; and also the *E. serialis*, which he does not appear to have regarded as a mere variety in his Catalogue Raisonné, 1846. In the meantime Phillips had enumerated, without a description, the variety *germinans* in the Geology of Yorkshire,† which Prof. McCoy republished, in 1848, as *E. diademata*, from the original locality. M. Cotteau's description and figures of his *E. multigranularis* are good representations of the typical *E. perlatus*; and lastly, Dr. Wright has described a large conical variety and a depressed one (the latter as *E. serialis*) from his own neighbourhood in Gloucestershire. His description rightly includes a synonymy of the several varieties, and this has been confirmed by the late Prof. E. Forbes, in the second edition of Morris's Catalogue, 1854. The var. *serialis* and that we here term *Forbesii* were not included in that synonymy, but, in accordance with the Professor's

* Unless indeed there is a general mistake in referring to that figure, which may very probably be intended for the *E. gyratus*. See note on that species.

† "His figure, a slight outline, is characteristic enough, but the avenues of pores are so indicated that the pores might be supposed to be in single file" (Forbes).

own views, as shown in the arrangement of the plate, and after carefully examining the specimens in the Museum of Practical Geology, they are here united; the var. *Forbesii* may, however, eventually be regarded as a distinct species.

Affinities.—If *E. bigranularis* of Agassiz (and its variety *E. intermedius*) be not the same species with ours, it must be closely allied. The description of M. Cotteau would make it appear to be a depressed variety much like *serialis*; it has but two rows of primaries in each area. It occurs with the *perlatus* in the Great Oolite of Grimaux, Yonne. According to M. Cotteau, *E. intermedius* of Agassiz is only a variety of *bigranularis*, a view in which Dr. Wright agrees. The *E. gyratus*, Agassiz, well figured by him in his *Ech. Suisses*, differs at first sight materially from the present species in the great number and small size of its tubercles, two and even three rows being arranged outside the principal ones, and one or two down the ambulacra. The latter are prominent, and the avenues sunk, and the median line of the intervening areas is bare of tubercles all the way down, and so much impressed that the species looks lobed. It is nevertheless a most closely related species.

Localities and Geological Range.—UPPER? and LOWER OOLITES. CORAL RAG, Malton, Scarborough (Prof. Phillips' and Brit. Museum Collection*). Var. *germinans*, GREAT OOLITE, Whitwell, Yorkshire (Forbes). INFERIOR OOLITE, Crickley Hill, Gloucestershire (Survey Collection); Leckhampton and Cleeve Hills (Survey Collection); Stroud; Nailsworth; Minchinhampton; Dundry (Dr. Wright).

Foreign Localities.—CORAL RAG (Etage Corallien), "Terrain à Chailles," Val de Moutiers, Ile de Ré; Salins; Besançon (Agass. and Desor). GREAT OOLITE (Terr. Bathonien), Grimaux, Département de l'Yonne (Cotteau). Var. *serialis*, Fringeli, Canton de Soleure (Agassiz).

* Dr. Wright has good reason for believing that this is an error of locality, and that *E. perlatus* is not found in Britain above the Great Oolite.

The Oolitic species of *Echinus* are so fully described, and also figured, by Dr. Wright, in the paper above referred to, that it is unnecessary to do more than enumerate them; the first mentioned, however, has not been yet figured in any British work.

1. *E. gyrratus*, Agass., Ech. Suisses, t. 23. f. 43-46., 1839; Catal. Raisonné, 1846, l. c., p. 366.; Forbes, in Morris's Catalogue, 2nd edit. (1854), 79. *E. petallatus*, M'Coy, Ann. Nat. Hist., 1848, vol. ii. p. 409.

E. biuncialis subconicus, pentagonus, lobatus, tuberculis numerosis—in *areâ ambulacrali ad basin quadrifariis, in alterâ seriebus sex vel octo—omnibus subequalibus; spatio mediano interambulacri lato lavigato; poris subparallelis.*

E. petallatus of M'Coy is undoubtedly this species. It is a very elegant one. In all probability Knorr's old figure belongs to it. Leske's certainly represents it far better than it does the *E. perlatus*.

Locality.—CORAL RAG. Wiltshire (Brit. Mus.); Besançon (Agass.); Havre (Brit. Mus.).

2. *E. granularis*, WRIGHT, Ann. and M. Nat. Hist. (1851), vol. viii. 2nd ser. p. 277.

A small species, distinguished from *E. perlatus* by its depressed and pentagonal form, and its granular appearance, the latter arising from the great number of tubercles, six or eight rows, in the interambulacral area.

Locality.—INF. OOLITE. Leckhampton Hill (DR. WRIGHT).

Of the Section *Arbacia*. Pores in single file.

E. (Arbacia) Forbesii, WRIGHT, l. c. pl. xiii. f. 4.

A small hemispheric species, with narrow convex ambulacra and interambulacral areas, depressed and almost lobed along the median line, covered by small equal tubercles.

Locality.—INF. OOLITE. Dundry (DR. WRIGHT).

E. (Arb.) nodulosa, WRIGHT, l. c. pl. xiii. f. 3.

Ech. nodulosus, GOLDFUSS, Pet. Germ. t. xl. f. 16.

A subpentagonal small species, covered with thick set tubercles, of larger size than in the last. The ambulacra are prominent.

Locality.—GREAT OOLITE. Sevenhampton Common, Gloucestershire. (DR. WRIGHT's Collection, Münster's specimen was found at Baireuth.)

EXPLANATION OF PLATE.

Fig. 1. *Echinus perlatus*, var. *germinans*; upper side, with anal disk complete (Malton). Cabinet of Prof. Phillips.

Fig. 2. The same; lateral view.

Fig. 3. Flattened under side, showing the pentagonal deeply-notched mouth.

Fig. 4. Outline of the large specimens of var. *germinans*, from the Inferior Oolite of Crickley Hill, Cheltenham.

Fig. 4a. Ambulacral and interambulacral plates of this variety, shewing the distinct circles of granules round the bosses, the pores in parallel ranks of threes.

Fig. 4b. Under side of do., showing the large secondary tubercles, and the pores in closer and more transverse rows, with granules among them.

Fig. 4c. Anal plates of a large specimen.

Fig. 5. Ambulacral and interambulacral plates of var. *serialis*. The ambulacral tubercles very irregular; magnified. Crickley Hill.

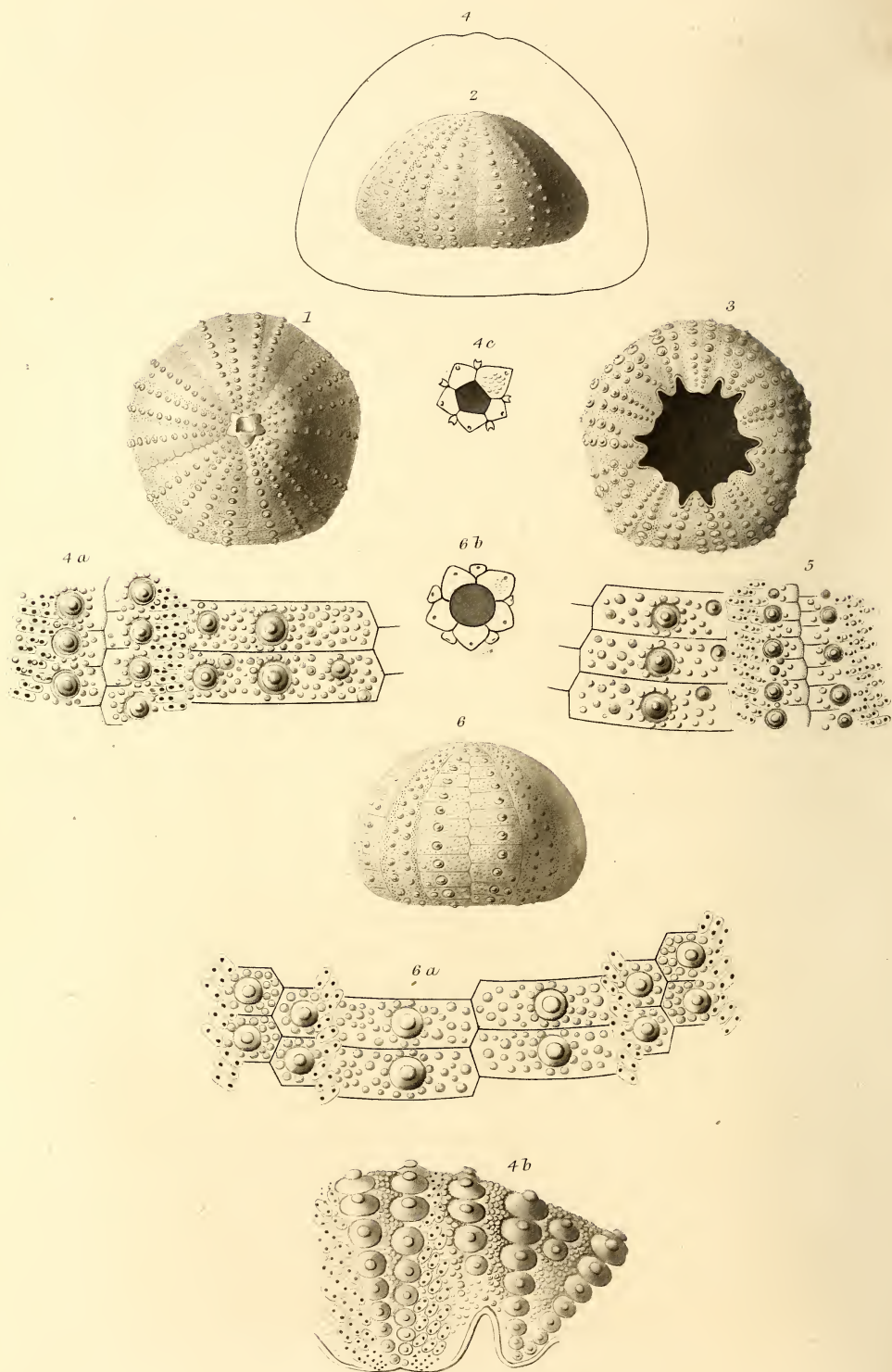
Fig. 6. Var. *Forbesii*, from Crickley Hill. This is evenly covered with granules, the primary tubercles therefore are more conspicuous.

Fig. 6a. Plates and pores of do. magnified, the triple series of pores very obliquely placed.

Fig. 6b. Anal plates of this variety. The madreporiform plate is not greatly enlarged.

March 1856.

J. W. SALTER.



ECHINUS PERLATUS—*Desmarest.*